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Final Report
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MATERIAL LABORATORY
NEW YORK NAVAL SHIPYARD
BROOKLYN 1, N. Y.

TECHNICAL REPORT

CRITICAL THERMAL ENERGIES
of
SPECIAL AWNING MATERIALS

Submitted by

THE BUREAU OF SHIPS, DEPARTMENT OF THE NAVY

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Lab. Project 5046-3, Part 27
Final Report
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Lab. Project 5046-3, Part 27
Final Report

ABSTRACT

Several plasticized and aluminized materials proposed for use as the canopies of special fire-support craft have been exposed to the Material Laboratory carbon-arc source of thermal radiation for the purpose of determining their resistance to thermal radiation. The critical thermal energies of the materials were measured; the apparent transmission of thermal energy was determined by measuring the effects on heat-sensitive paper backing. Initial damage effects occur at radiant exposures ranging from 0.56 to 14 cal/cm^2, and final destruction at exposures ranging from 10 to 90 cal/cm^2, when the energy is delivered at a rate of application of 85 cal/cm^2 sec. While the resistance of the plasticized materials is greater than that of the aluminized materials, the apparent transmittances of the aluminized materials are somewhat higher.

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SECURITY INFORMATION

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Ref: (a) COMNYKNAVSHIPYD Conf ltr S99/L5, Ser 960-92 of 14 Mar 1950
(b) BUSHIPS Restr spdltr S99-(0)(348) Ser 348-75 of 6 Apr 1950
(c) BUSHIPS Restr ltr S90/1-5(348) Ser 348-207 of 29 May 1952
(d) BUSHIPS Restr ltr S90/1-5(348) Ser 348-232 of 15 Jul 1952

Encl: (1) Critical Thermal Energies of White Plasticized Materials
(2) Critical Thermal Energies of Aluminized Materials
(3) Apparent Transmittances of Plasticized and Aluminized Materials

AUTHORITY

1. This investigation is part of the program proposed by reference (a) and formally approved by reference (b). The general Thermal Radiation program is under the Supervision of the Armed Forces Special Weapons Project.

INTRODUCTION

2. As part of its general program on the effects of the thermal radiation of atomic explosions on materials, the Material Laboratory is evaluating the characteristics under exposure to thermal radiation of various materials of particular interest to the several agencies of the Department of Defense. As data become available, these findings are published.

3. The Bureau of Ships requested the evaluation of several plasticized and aluminized materials which had been proposed for use on the canopies of special fire-support craft now being designed. The plasticized materials included duck and glass fabrics with vinyl and silicone treatments. The aluminized materials included these and other fabrics with an aluminum pigment added to the plasticizer.

EQUIPMENT AND METHODS OF EXPOSURE

4. The critical thermal energies of the treated fabrics were determined, employing the Material Laboratory carbon-arc source of thermal radiation. The source consists of an 11-mm carbon arc mounted at the focus of a reflector which collimates the emitted energy; a second mirror which is mounted coaxially at a distance of 12 feet from the collimator, condenses the radiation to the mirror's focus. Gradations of thermal damage are obtained by varying the effective exposure time through accelerating a 1x8-inch sample transversely through the focus. The rate of application of energy was 85 cal/cm^{2}sec, over a central area 2 mm wide.

5. Since not only the destructive effects on the treated materials are important, but also the amount of energy transmitted through such materials, the apparent transmittance of thermal radiation was determined. The apparent transmittance of thermal radiation was measured by exposing the materials to the carbon-arc source with indicators, in the form of black carbon paper and M-6 vesicant detector paper, mounted behind the assemblies with an air gap of 1/16-inch. The energies incident on the fabric which would produce certain effects on the indicator papers and the total energies required to produce the same effects directly on the papers were measured; the apparent transmittances of the assemblies were computed as the ratios of these two values. It may be noted that the apparent transmittance of an assembly does not have to be identical for several indicators or effects, since the heat transfer and reaction of material assemblies at elevated temperatures are influenced by the duration of exposure, the rate of application of energy and characteristics of the materials. Nevertheless, the apparent transmittance is a useful index of the relative merits of several materials since the same methods of exposure are employed in all cases.

RESULTS AND CONCLUSIONS

6. The critical thermal energies of the fabrics submitted by the Bureau of Ships are defined as those which produce certain characteristic, reproducible effects on the materials, such as blistering, discoloration and charring. In addition, the initial occurrence of flaming was noted. The critical thermal energies of the materials are listed in Enclosures (1) and (2). The apparent transmittances of the fabrics are given in Enclosure (3).

7. Analysis of the data given in Enclosures (1) through (3) indicates that the thermal radiation resistance of the plasticized materials is greater than that of the aluminized materials and that the apparent transmittances of the two classes of materials are approximately the same. The best materials from the standpoint of resistance and transmittance are the vinyl-on-glass and silicone-on-glass combinations.

8. To summarize the results of this investigation, the special fabric materials submitted by the Bureau of Ships suffer complete destruction upon exposure to the carbon-arc source of thermal radiation at radiant exposures ranging from 10 to 90 cal/cm^2 at a rate of application of energy of 85 cal/cm^{2}sec. Initial destructive effects take place at radiant exposures ranging from 0.56 to 14 cal/cm^2. The thermal radiation resistance of the plasticized materials is greater than that of the aluminized materials. The apparent transmittances of the materials, determined by effects on carbon-paper backing, range from 1.4 to 5.2 per cent. The silicone-on-glass and vinyl-on-glass combinations have a high critical energy for destruction and a low apparent transmittance.

Approved:

H. T. Koonce

H. T. KOONCE, CAPTAIN, USN
The Director

CRITICAL THERMAL ENERGIES OF PLASTICIZED MATERIALS

Material	Description of Effect	Critical Energy cal/cm^2
Vinyl on No. 10 Duck (Wm. E. Hooper & Sons)	Blistering of top surface	6.9
	Sporadic charring	6.4 - 10
	Regular charring	10
	Flames during exposure	11-13
	Back surface blackens	45
	Turns brittle and cracks on manipulation	55
Vinyl on No. 126 Glass (Mobile Plastics Co.)	Blistering of top surface	7.6
	Sporadic charring	9.0 - 17
	Regular charring	17
	Flames during exposure	17
	Back surface blisters	17
	Vinyl on top surface destroyed, glass fiber exposed	44
	Vinyl on back surface destroyed	73
	Glass fiber destroyed	90
Vinyl on No. 126 Glass (Duracote Co.)	Sporadic charring	14
	Flames during exposure	18
	Regular charring	18
	Back surface darkens	27
	Vinyl on top surface destroyed, vinyl on back surface stiffens	46
	Glass fiber and vinyl on back surface destroyed	72
Silicone on glass No. 3010(Connecticut Hard Rubber Co.)	Flames during exposure	14
	Regular charring	14
	Back surface blisters	31
	Turns brittle and cracks on manipulation	73
Silicone on glass No. 3016(Connecticut Hard Rubber Co.)	Sporadic charring	14-21
	Flames during exposure	18
	Regular charring	21
	Blisters on back surface	44
	Turns brittle and cracks on manipulation	68

CRITICAL THERMAL ENERGIES OF ALUMINIZED MATERIALS

Material	Description of Effect	Critical Energy, cal/cm^2
Aluminum Pigmented Nylon, E-284 G (U.S. Rubber Co.)	Surface dulls	1.0
	Charring	5.8
	Flames during exposure	8.6
	Turns brittle and cracks on manipulation	10
	Flame propagates after exposure	13
Aluminized Vinyl on Nylon, Fiberthin "B" (U.S. Rubber Co.)	Surface dulls	1.6
	Flames during exposure	4.3
	Charring	4.3
	Holes appear in material	14
	Destroyed	22
Aluminum Pigmented Vinyl on No. 126 glass (Mobile Plastics Co.)	Surface dulls	0.99
	Turns golden color	1.9
	Surface blackens	3.7
	Flames during exposure	8.6
	Back surface blisters	16
	Turns brittle and cracks on manipulation	65
Aluminum Pigmented Vinyl on No. 10 Duck (Wm. E. Hooper & Sons)	Surface dulls	2.2
	Turns golden color	2.8
	Surface blackens	4.7
	Flames during exposure	5.6
	Back surface blisters	22
	Back surface blackens, material stiffens and cracks on manipulation	44
Aluminum on Asbestos-Glass, S/915 (U.S. Rubber Co. & Minn. Mining & Mfg. Co.)	Charring	7.2
	Flames during exposure	8.5 -13
	Back surface blackens	15
	Turns brittle and cracks on manipulation	46
Duck, Spec. No. 24C20, Std. Stk G-24-D-257-140	Surface discoloration	0.56
	Surface blackens	0.81
	Flames during exposure	5.6
	Back surface blackens	23
	Turns brittle and cracks on manipulation	35

APPARENT TRANSMITTANCES OF FABRICS

Material	EFFECT ON INDICATOR			Radiant Exposure on Material cal/cm^2	Apparent Transmittance %
	Indicator	Description of Effect	cal/cm^2		
Vinyl on No. 10 Duck(Wm.E. Hooper & Sons)	Carbon paper	Dulling of surface	0.06	5.0	1.2
	Carbon paper	Destroyed	0.78	53	1.5
Vinyl on No. 126 Glass(Mobile Plastics Co.)	Carbon paper	Dulling of surface	0.06	1.2	5.0
	Carbon paper	Destroyed	0.78	17	4.6
	M-6 Ves. Det.	Turns orange	0.44	16	2.7
	M-6 Ves. Det.	Paint Distils off	5.9	90	6.5
Vinyl on No. 126 Glass(Duracote Co.)	Carbon paper	Dulling of surface	0.06	2.4	2.5
	M-6 Ves. Det.	Turns orange	0.44	18	2.4
	Carbon paper	Destroyed	0.78	46	1.7
	M-6 Ves. Det.	Paint Distils off	5.9	75	7.8
Silicone on glass, No. 3010(Connecticut Hard Rubber Co.)	Carbon paper	Dulling of surface	0.06	5.2	1.2
	M-6 Ves. Det.	Turns orange	0.44	14	3.1
	Carbon paper	Destroyed	0.78	27	2.8
Silicone on glass No. 3016(Connecticut Hard Rubber Co.)	Carbon paper	Dulling of surface	0.06	7.3	0.82
	M-6 Ves. Det.	Turns orange	0.44	18	2.4
	Carbon paper	Destroyed	0.78	41	1.9
Aluminum Pigmented Nylon,E-284-G (U.S. Rubber Co.)	Carbon paper	Dulling of surface	0.06	1.8	3.3
	Carbon paper	Destroyed	0.78	11	7.1
Aluminized Vinyl on Nylon,Fiberthin "B"(U.S.Rubber Co.)	Carbon paper	Dulling of surface	0.06	5.6	1.1
	M-6 Ves. Det.	Turns orange	0.44	15	2.9
Aluminum Pigmented Vinyl on No. 126 Glass(Mobile Plastics Co.)	Carbon paper	Dulling of surface	0.06	6.3	0.95
	M-6 Ves. Det.	Turns orange	0.44	14	3.1
	Carbon paper	Destroyed	0.78	49	1.6
Aluminum Pigmented Vinyl on No. 10 Duck(Wm.E. Hooper & Sons)	Carbon Paper	Dulling of surface	0.06	6.7	0.89
	M-6 Ves. Det.	Turns orange	0.44	18	2.4
	Carbon paper	Destroyed	0.78	49	1.6

APPARENT TRANSMITTANCES OF FABRICS

Material	EFFECT ON INDICATOR			Radiant Exposure on Material cal/cm^2	Apparent Transmittance %
	Indicator	Description of Effect	cal/cm^2		
Aluminum on Asbestos Glass S/915, (U.S. Co. & Minnesota Mining & Mfg. Co.)	Carbon paper	Dulling of surface	0.06	8.0	0.75
	Carbon paper	Destroyed	0.78	26	3.0
Duck, Spec. 24C20 No.10, Std. Stk. (G-24-D-257-140)	Carbon paper	Dulling of surface	0.06	5.2	1.2
	M-6 Ves. Det.	Turns orange	0.44	14	3.1
	Carbon paper	Destroyed	0.78	43	1.8

3 September 1952

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